CANARYSEED: A PROMISING NEW FOOD CROP

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INTRODUCTION

Canaryseed or annual canarygrass (*Phalaris canariensis* L.) has become an important crop in western Canada, particularly in Saskatchewan which accounted for over 90% of the total canaryseed production in 1995. Canaryseed is a cereal crop belonging to the Gramineae family and the Pooideae subfamily similar to wheat, barley, rye and oat, but it belongs to a different tribe (Agrostixeae). It is currently used as a feed for small songbirds. Early reports indicate that canaryseed flour was mixed with wheat flour to bake bread and was also used in making a gruel for human consumption in Italy (Kornick and Werner 1885). Development of canaryseed as a food crop should expand its usefulness and increase its value.

The current cultivars of canaryseed are not safe for human consumption because the attached hulls are covered by small silicified hairs or spicules that can contaminate the groat during dehulling. These hairs have been linked to cancer of the oesophagus when they were present as a contaminant in wheat flour used in baking bread (O'Neill et al. 1980). The hairs are also a problem in canaryseed production as they cause irritation to combine operators and grain handlers. Because of the problems associated with the existence of canaryseed hairs, processes have been developed in order to eliminate the hairs from the current cultivars. A hairless glabrous cultivar has been developed. A chemical treatment was developed which is capable of digesting the hairs from traditional cultivars. Chemical and technological evaluations will result in adding value to this crop. The objectives of the present study were to investigate the chemical composition of canaryseed and to characterize its components (starch, protein and oil) in order to evaluate their potential in food applications.

CANARYSEED GRAIN

The hairy canaryseed cultivar 'Keet' was obtained from field trials grown at three sites (Saskatoon, Kemen and Elrose) in central Saskatchewan in 1993. The glabrous cultivar was obtained from an increase plot grown at Saskatoon in 1995. A photomicrograph for the hairy, glabrous and processed hairy canaryseed are presented in Figure 1. This photomicrograph shows the presence of the hairs in the current cultivar and the absence of hairs in the glabrous cultivar and the processed hairy grain. Canaryseed grains are very small and elliptical in shape, having-a kernel weight of 7 mg and test weight of 63 kg/h1 (Hucl et al. 1995). Canaryseed grains were dehulled by an abrasive dehuller and air-

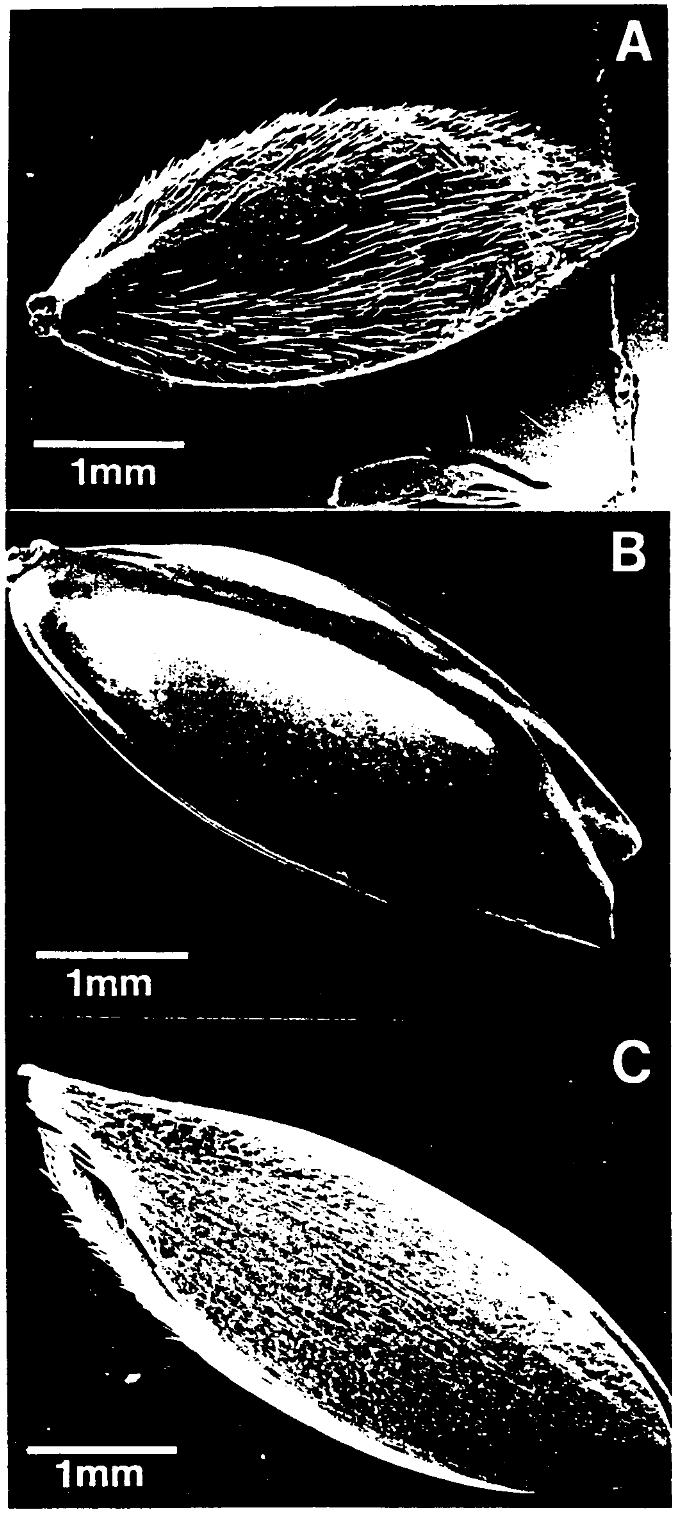

Figure 1. Photomicrographs of canaryseed grains: (A) hairy, (B) hairless and (C) processed hairy seeds showing the presence and absence of silicified hairs on the attached hulls.

aspirated to remove the hulls. The hulls constituted approximately 35% of the grain weight. The hull-free grams or groats were then ground and stored for analysis. Canaryseed flour was obtained by roller milling of the tempered groats.

CHEMICAL COMPOSITION

The chemical compositions of canaryseed groats, flour and bran are compared to that of wheat grain in Table 1. Starch was the major constituent of canaryseed, averaging 61.0% in the groats, which was comparable to that of wheat. Canaryseed contained lower concentrations of sugars and soluble and insoluble dietary fiber than wheat. On the other hand, canaryseed had relatively high concentrations of protein and oil for a cereal containing about 20% more protein and four times more oil than wheat. After milling, starch was concentrated in to the flour fraction and oil separated partially into the bran fraction, while the protein content was similar in both fractions.

Table 1. Chemical Composition of Canaryseed and Milled Products in Comparison with Wheat (% DB)

Constituent	Canaryseed			Wheat
	Groat	Flour	Bran	
Product yield	100	75	25	100
Starch	61.0	66.8	35.1	62.0
sugars	1.7	1.5	1.8	2.8
Soluble dietary fiber	0.9	0.1	2.1	2.1
Insoluble dietary fiber	5.1	0.9	16.7	10.5
Protein (N x 5.7)	20.3	20.2	21.4	15.0
Oil	8.7	5.6	12.7	2.3

CANARYSEED STARCH

The chemical components in canaryseed groats and wheat grain were extracted by the wet milling method. The efficiencies of starch extraction were higher in canaryseed than for wheat, where gluten proteins rendered starch isolation more difficult (Table 2). The small wheat starch granules were only isolated.

The characteristics of canaryseed starch was markedly different than wheat starch (Table 2). On a dry basis, the starch concentrations in the isolates were identical at 95%. But the amylose contents in canaryseed starch were substantially lower than in wheat starch. The uniform small polygonal granules of canaryseed starch had an average diameter of 2.0 µm while wheat starch consisted of larger circular granules with an average diameter of 3.8 µm. The granules were stable when subjected to shear and heat effects as indicated by visco/amylograph response and thermal properties. Canaryseed starch showed higher peak viscosity than for wheat starch. The transition temperatures of canaryseed starch gelatinization (onset, peak and conclusion) and enthalpy of gelatinization were also higher than those of wheat starch. Based on X-ray diffraction analysis, canaryseed starch showed major peaks around d-spacing of 5.9, 5.2, 4.8 and 3.8 A, similar to wheat starch which are characteristics of A-type starch.

Canaryseed starch was found to form a rigid gel which was stable under cooling and freezing conditions. When the gels were stored at 4°C or -15 °C to measure their stability during refrigeration and a freezing and thawing cycle, the degrees of syneresis were less than 3.0% at both temperatures.

Table 2. Characteristics of ***Canaryseed and Wheat Starches***

Property	Canaryseed	Wheat
Yield (g/l 00g)	49.7	46.8
Starch (%)	94.4	94.6
Amylose (%)	17.2	22.7
Shape	Polygonal	Circular
Diameter (µm)	2.0	3.8
Peak viscosity (BU)	497	440
T_o & T_p & T_c (“C)	55.1&65.4&75.6	54.0&59.3&69.9
Enthalpy of gelatinization (J/g)	9.5	8.9
X-ray pattern	A-type	A-type
d-spacing (A)	5.9&5.2&4.8&3.8	5.9&5.2&4.9&3.8

CANARYSEED PROTEIN

The most limiting essential amino acids in plant proteins for human and animal diets are reported in Table 3 for canaryseed, wheat and casein proteins. It is well known that wheat proteins are seriously deficient in lysine and moderately deficient in threonine. Canaryseed proteins had only two-thirds of the lysine of wheat but were comparable to wheat in threonine content. The methionine concentration in canaryseed proteins was also comparable to that of wheat, which was only one-half of the levels in casein and the FAO pattern. The deficiency in this sulphur-containing amino acid is compensated by the presence of high concentrations of cystine which is methionine-sparing during synthesis of protein in humans. The level of tryptophan in canaryseed proteins was exceptionally high, 2.8 g/100 g protein. This level would make canaryseed protein an excellent supplement or blending protein for other cereal or animal protein sources that barely meet the FAO pattern for tryptophan. For example, canaryseed protein would be a good supplement protein source for dairy proteins such as casein and whey proteins. Like wheat protein, canaryseed proteins were lower in digestibility than milk proteins, which would further reduce the nutritive value of canaryseed proteins.

The proportions of canaryseed and wheat protein fractions, based on their solubility in water, salt, alcohol and alkali, are reported in Table 4. Albumins and globulins occurred in low concentrations in canaryseed, about half of those in wheat protein. Prolamins were the major storage proteins in canaryseed, being 45.5% of total protein, compared to 37.1% for wheat protein. The total prolamin and glutelin constituted 78% of the total protein in canaryseed. But, the prolamin to glutelin ratio in canaryseed of 1.4 was higher than that of wheat (1.0). This high ratio supports the finding that canaryseed flour has the potential to produce high viscosity dough in blends with wheat flour.

***Table* 3. Amino Acid Composition (g/100 g protein) and Protein Digestibility (%) of Canaryseed in comparison with wheat and casein proteins**

Amino acid	Canaryseed	Wheat	Casein	FAO pattern'
Lysine	1.3	1.9	7.2	5.8
Threonine	2.7	2.8	4.0	3.4
Tryptophan	2.8	1.2	1.0	1.1
Methionine	1.4	1.4	2.8	2.5
Cystine	3.3	2.3	0.5	
Protein digestibility	84.0	86.6	97.6	

'FAO/WHO/UNU (1985) pattern for pre-school child (2-5 years).

Table 4. Protein Composition of Canaryseed in comparison with wheat proteins

Protein fraction	Canaryseed	Wheat
Albumin	5.7	13.2
Globulin	7.4	10.4
Prolamin	45.5	37.1
Giutelin	32.2	36.4
Residue	9.2	3.0

CANARYSEED LIPID

The total lipid or chloroform/methanol (2: 1 v/v) extract was 11.0% for canaryseed groats, but only 2.6% for wheat (Table 5). Crude fat or ether extract was 8.7% in canaryseed groats and 2.3% in wheat, indicating that a high proportion of canaryseed lipid consisted of polar lipids. Both canaryseed and wheat lipids were highly unsaturated and potentially subject to rapid rancidity. Canaryseed lipid had a higher ratio of unsaturated to saturated fatty acids, 7.5, than the 5.0 obtained for wheat lipid. However, canaryseed lipid contained less polyunsaturated fatty acids, 57.5% than the 68% for wheat lipid. In addition, canaryseed lipid is known to exhibit antioxidant activity in which sterol and titerpene alcohol esters of caffeic acid are the major effective antioxidant components in the crude oil (Takagi and Iida 1980). The relatively lower polyunsaturated fatty acids and/or the presence of antioxidant activity in canaryseed lipid could be a delaying factor in rancidity of canaryseed products during storage.

Table 5. Lipid and fatty acid composition of Canayseed in comparison with wheat

Constituent	Canaryseed	Wheat
Total lipid (%)	11.0	2.6
Crude fat (%)	8.7	2.3
Fatty acid (% of total fatty acids)		
Linoleic	55.4	61.2
Oleic	29.1	16.6
Palmitic	10.7	15.8
Linolenic	2.7	4.6
Stearic	1.0	0.8

CONCLUSIONS

Canaryseed is a promising alternative cereal grain crop based on its chemical composition. The starch was easily isolated on the basis of its extraction efficiency and high purity. The granules were imiformly small with a low amylose content that did not gelatinize below 95 °C during cooking. The high protein contents (average 18.7%) and predominance of prolamin and glutelin fractions (78%) in the proteins suggest unique functional properties. Canaryseed proteins were very low in lysine and threonine but were exceptionally rich in tryptophan and cystine that could be important in nutritional protein blends. The high contents of polar and nonpolar lipids could be valuable by-products of component-extracted canaryseed. Their high compositions of polyunsaturated fatty acids are reported to be stabilized by antioxidants such as esters of caffeic acid.

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REFERENCES

FAO/WHO/UNU. 1985. Energy and protein requirements. WHO Technical Report Series No. 724. Geneva: World Health Organization.

Hucl, P.; Vandenberg, A.; Abdel-Aal, E-S. M.; Ma, H.; Sosulski, F. W. and Hughes, G. R. 1995. New initiatives in canaryseed development. In Proceedings of the Cropportunities III Conference. Extension Division, Univ. of Saskatchewan, Saskatoon, P. 51-56.

Körnick, F. and Werner, H. 1885. Handbuch des Getreidebaues, Berlin.

O'Neill, C. H.; Hodges, G. M.; Riddle, P. N.; Jordan, P. W.; Newman, R. H.; Flood, R. J. and Toulson, E. C. 1980. A fine fibrous silica contaminant of flour in the high oesophageal cancer area of north-east Iran. Internal. J. Cancer. 26: 617-628.

Takagi, T. and Iida T. 1980. Antioxidant for fats and oils from canary seed: Sterol and triterpene alcohol esters of caffeic acid. J. Amer. Oil. Chem. Soc. 57: 326-330.